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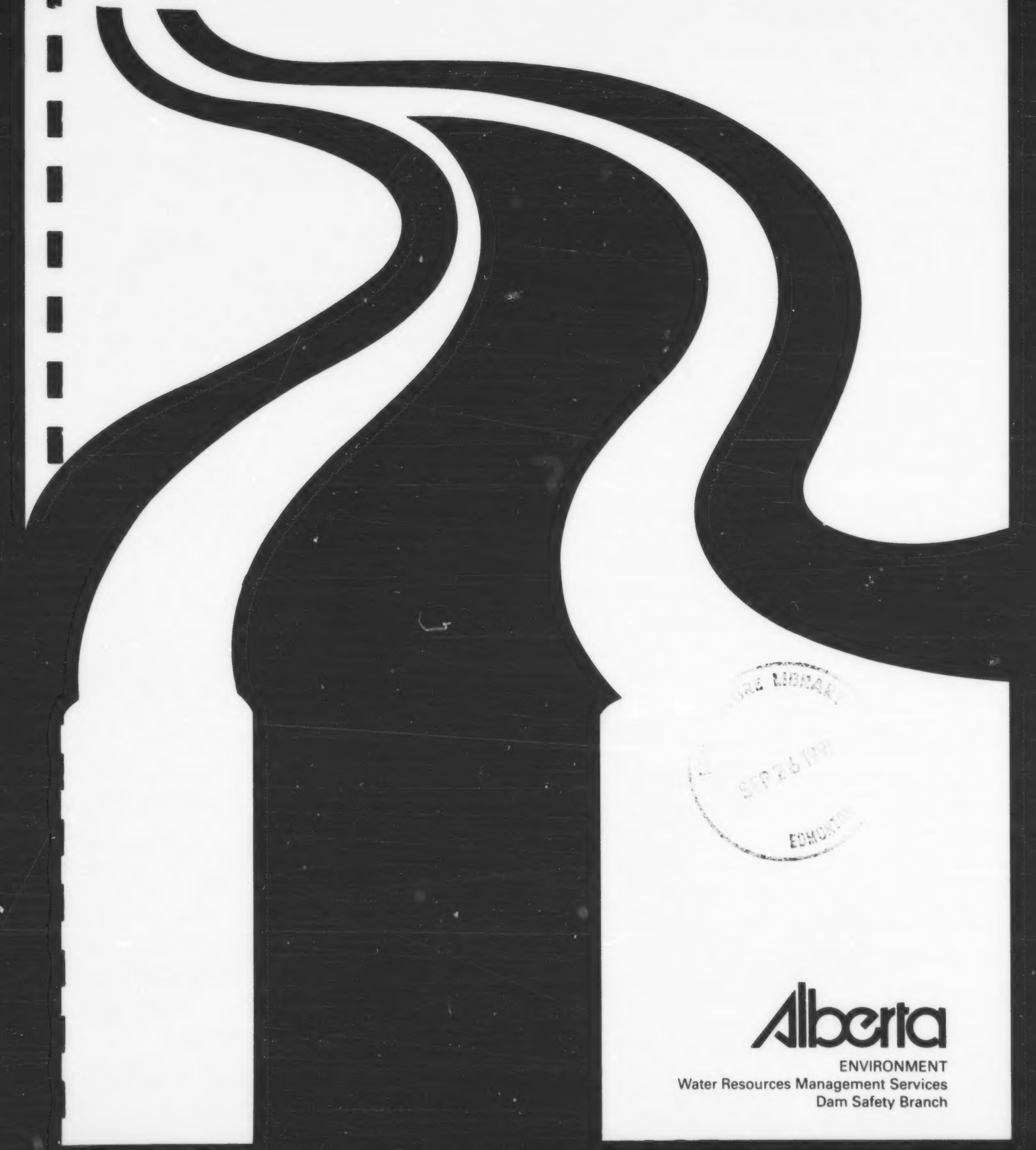
Engineering Report



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ENVIRONMENT
Water Resources Management Services
Dam Safety Branch

REPORT ON THE FAILURE OF MOUND RED PARK RESERVOIR (MUSKEG CREEK DAM)

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Date: April, 1991

92-00074/

REPORT ON THE FAILURE OF

MOUND RED PARK RESERVOIR

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- EROSIONAL DAMAGE - SPILLWAY AREA
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1. INTRODUCTION

Mound Red Park Reservoir (Muskeg Creek) is located in NW 11-45-28-4, approximately 10 km south of the Summer Village of Ma-Me-O Beach. The reservoir construction was started in the early 1960's by the Wetaskiwin Fish and Game Association, the licencee of record. In 1968, the County of Wetaskiwin and the Water Resources Division of the Alberta Department of Agriculture, constructed the concrete chute spillway located at the south end of the dam. In 1970, a structural steel pedestrian bridge was built across the spillway inlet channel, 12 metres upstream from the spillway headwalls.

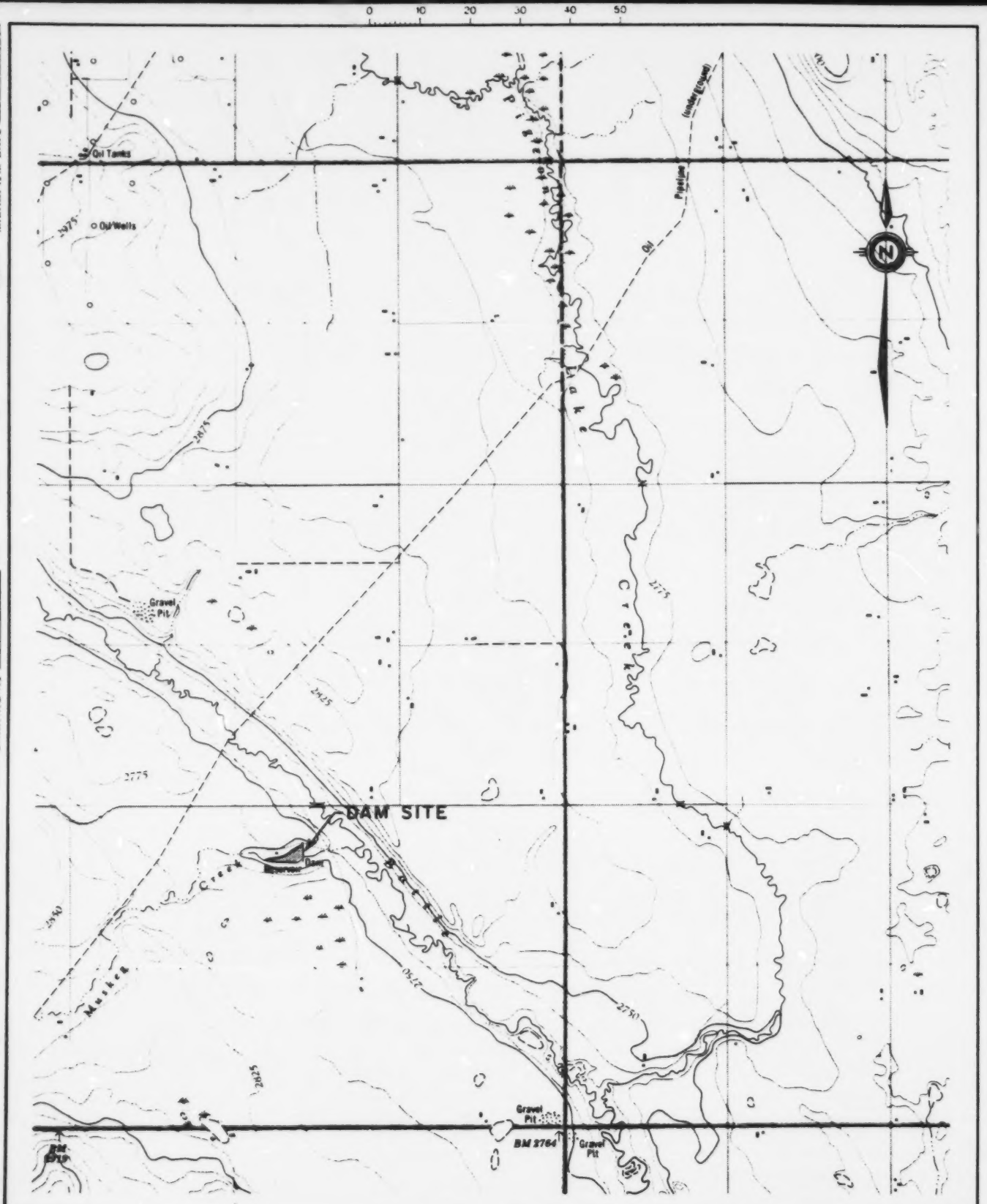
This project provides a popular recreational area; fishing and camping being the main uses.

In October 1988, a study was undertaken by Alberta Environment to determine the feasibility of:

1. raising the existing reservoir full supply level (FSL) by 1 and 2 metres respectively; and
2. improving the deteriorating fish habitat.

This study was completed and a report issued in November 1989. Much of the hydrological information used in this report was taken from that study.

On July 3, 1990, the Muskeg Creek Dam overtopped and failed. This report gives details of the events leading up to the failure and suggests possible causes.



Alberta
ENVIRONMENT

MOUND RED PARK RESERVOIR (MUSKEG CREEK DAM)

LOCATION PLAN

N.W. 11-45-28-4

SUBMITTED DATE	DESIGNED CHECKED
APPROVED DATE	DRAWN CHECKED
SCALE 1:50 000	SHEET 1 OF
DATE OCT. 1990	FILE No. 10773

2. PROJECT DATA

Embankment

The project consists of an earthfill embankment approximately 8.5 metres high, 115.0 metres long with a crest width of approximately 5.0 metres. Crest elevation is generally 836.0 metres with 3 H:I V upstream and downstream slopes. A survey conducted in December of 1988 (see Appendix) revealed a low area with an elevation of 835.7 metres on the maximum fill section of the crest, which reduced the effective freeboard to 1.82 metres.

Reservoir

The reservoir with a capacity of 68,000 cubic metres (68.0 dam^3) and an area of 3.7 hectares is supplied by a drainage basin of 87.7 square kilometres through which the intermittent Muskeg Creek flows. Muskeg Creek joins the Battle River approximately 0.5 kilometres below the dam.

Spillway

The spillway, located at the south end of the embankment next to the right abutment, consists of a concrete chute with a fixed sharp crested weir 9.4 metres wide, at an elevation of 833.88 metres. Records indicate that during construction of the spillway there were problems with sloughing and ground water discharge on the abutment. These problems were apparently brought under control and the spillway was completed. However, for a number of years, there has been continued minor seepage and the existence of a shallow, inactive slide on this abutment.

Existing documentation on the spillway does not indicate the flood frequency used in designing the spillway. Nor are there any records indicating spillway flow characteristics for various heads and the accompanying capacities.

On p.8 of the 1989 study, a 1:100 year flood was given as having an instantaneous flow of 32.0 cubic metres per second. Our calculation to determine the maximum spillway capacity is as follows:

$Q = 1.8 \times b \times H^{3/2}$ Where Q = flow in cubic metres per second
1.8 = constant
b = width of weir
H = head (top of chute walls to weir)

$Q = 1.8 \times 9.445 \times 1.7^{3/2}$
= 37.68 cubic metres per second

Low Level Conduit

A low level outlet consisting of two 300 mm C.S.P.'s is located at approximately Sta. 0+57 which is close to the mid-point of the crest length. Access to the control valves is via twin 600 mm C.S.P. shafts located approximately 8.0 metres downstream. The type of valve, their present condition and maximum discharge capacity is unknown at this time. They were last used just prior to the December 1988 geotechnical investigation to lower the reservoir some 6.0 metres.

3. HYDROLOGY

The following hydrology data for Mound Red Park reservoir is taken directly from the Development & Operations Level I Report of November, 1989:

Hydrograph Volumes

The hydrograph peak volumes for different floods are given below:

Flood Frequency	Hydrograph Volume (dam^3)	Peak Flow - Instantaneous (cms)
1:2	2333.0	5.5
1:5	4406.0	11.9
1:10	6134.0	16.6
1:25	8381.0	22.8
1:50	10195.0	27.5
1:100	11837.0	32.0

The above table shows that even for the 1:2 year flood, the flood volume exceeds by far the capacity of the reservoir estimated at only 68 dam^3 under the existing FSL.

The report also notes that due to the small size of the reservoir, routing has no attenuation effect on the inflow flood, i.e., the outflow is practically the same as the inflow.

Precipitation Data

The precipitation statistics for the Muskeg Creek drainage basin area are:

1:25 year, 24 hour rainfall event is approximately 90 mm

1:100 year, 24 hour rainfall event is approximately 110 mm

For the period July 2-3, 1990, most of the area received in excess of 125 mm of rainfall with some areas reporting as much as 171 mm of rainfall, most of which fell in an 18-24 hour period (see rainfall map in Appendix). These quantities of rainfall are well in excess of the 1:100 year, 24 hour rainfall event.

The existing statistics for rainfall events in this area are based on data collected from an area covering Edmonton in the north, Red Deer in the south and Rocky Mountain House in the west.

1:25 Year and 1:100 Year, 24-Hour Rainfall (mm)
for Climate Stations in Central Alberta

Station Name	24-Hour Rainfall (mm) 1:25 Yr.	1:100 Yr.
Edmonton International Airport	77	94
Edmonton Municipal Airport	91	114
Edmonton Namao Airport	89	109
Ellerslie	86	107
Lacombe CDA	86	106
Red Deer Airport	93	117
Rocky Mountain House	91	113

While the various locations indicate some variability in the 1:25 year and 1:100 year, 24-hour precipitation, the differences are relatively minor and are likely due to differences in the length of record for each of the sites. In this regard, it may be concluded that this entire region is relatively homogeneous in terms of rainfall, and that the 1:25 year and 1:100 year, 24-hour rainfall

are about 90 millimetres and 110 millimetres respectively throughout the entire region. The length of record for these reporting stations varies from twenty to one hundred years. As the length of record increases, these values may change slightly but not enough to significantly alter the existing precipitation frequencies. Therefore, it can only be concluded that the precipitation of July 2-3, 1990 was well in excess of the 1:100 year event.

Stream Flow Data

The following is a summary of the return periods of various streams in the area for the July 2-3, 1990 flood event.

Site	Maximum Instantaneous Discharge (CMS)	Return Period (Years)
Blindman River Near Blackfalds (Tributary of the Red Deer River & 60 km south of Mound Red)	410	>1:100
Blindman River Near Bluffton (Approx. 22 km west of Mound Red)	300	1:80
Lloyd Creek near Bluffton (Tributary of the Blindman River approx. 22 km west of Mound Red)	241	>1:100
Battle River near Ponoka (Approx. 30 km SE of Mound Red)	275	>1:100

From these data it can be seen that the storm and resulting flooding of July 2-3, 1990 was a regional event. There was also a gauging station 0.25 km downstream of the dam, which has only been in operation since July 1982. The high water elevations graph (see Appendix) depicts the July 2-3, 1990 flood event. This gauging

station is located on the upstream side of a bridge which is part of a farm access road. The water elevations on this graph were affected by:

1. restricted flow under the bridge;
2. restricted flow caused by debris blocking flow under the bridge and causing a rise in backwater until it overtopped and eroded the road base on each side of the bridge.

4. FAILURE

On July 3, 1990, inflows exceeded the spillway capacity and the wing walls were overtopped by approximately 0.42 metres. The reservoir level continued to rise until the dam itself was overtopped by approximately 0.3 metres of water across the 35 - 40 metre width of the low area of the crest (see Profiles & Cross-Section Plan in Appendix). The failure spanned a 6 to 7 hour period resulting in erosional damage to the downstream slope of the embankment and the chute spillway.

5. DAMAGE

Embankment

Erosional damage occurred on the downstream slope of the embankment corresponding to the 35 - 40 metre wide low area on the crest. The damage consisted of the downstream slope being cut vertically along the downstream edge of the crest to a depth of approximately 3.0 metres and extending approximately 6 - 7 metres downstream (see Erosional Damage - Main Dam and General Plan in the Appendix). The erosion had started to cut back into the crest as can be seen on this plan and would have eventually breached the embankment had the overtopping continued. It is assumed that

erosional damage occurring simultaneously at the spillway provided an increased outflow which lowered the reservoir level and prevented further overtopping of the main embankment.

Spillway

Witnesses at the site indicate that an erosion gully developed on the left side of the spillway and later on the right side. The erosion gullies progressed to a depth of 1 to 3 metres below the spillway floor slab and approximately 15 metres on either side of the spilllway (see Erosional Damage Plan in Appendix). The inlet channel was badly eroded and the pedestrian walkway and its retaining walls were left unsupported.

Downstream Channel

Approximately 0.25 kilometres downstream from the embankment a farm access road bridge crosses the channel. The bridge is a timber structure with a concrete deck. Flows under the bridge were restricted by an accumulation of debris which resulted in the bridge being overtopped by approximately 0.45 metres of flood water until both bridge abutments were eroded. The Westerose Gauging Station (05FA912) located on the upstream side of the bridge was also damaged.

6. SUMMARY

The storm of July 2-3, 1990, was in excess of the 1:100 year event. Due to the small size and capacity of the Mound Red Park reservoir, any

event of a 1:2 year return period or greater would exceed the reservoir capacity and create a flow through situation where the outflow would equal the inflow.

The Battle River, to which Muskeg Creek is a tributary, experienced flows in excess of the 1:100 year event during the July 2-3, 1990, storm (see Stream Flow Data p. 7). Flows from Mound Red Park reservoir did not significantly affect those of the Battle River due to the flow through conditions. The impact of additional inflows to the Battle River as a result of the failure of the Mound Red Park spillway is mitigated by the small volume involved (68,000 cubic metres) and the 6-7 hour failure period.

7. CONCLUSIONS

1. The Mound Red Park Reservoir failed from overtopping as a result of a regional storm in excess of the 1:100 year event.
2. The failure did not contribute to flood damage along the Battle River.
3. If this project is to be rebuilt, consideration should be given to:
   - increasing the freeboard to allow for increased storm related storage;
   - constructing an emergency spillway.
4. Elevation differentials along the crest of a dam caused by settlement or other reasons should be monitored periodically and eliminated during routine maintenance.
5. Due to the magnitude of the July 1990 flood event, the flood hydrographs for this project should be re-evaluated.

PHOTO NO. 8609-19
MOUND RED PARK RESERVOIR SPILLWAY OPERATING IN 1986

PHOTO NO. 9051-18
MOUND RED PARK RESERVOIR SPILLWAY
ONE WEEK AFTER JULY 3, 1990 FAILURE

PHOTO NO. 9066-6
JULY 4, 1990

PHOTO NO. 9066-3
JULY 4, 1990

PHOTO NO. 9066-11 - JULY 4, 1990
NOTE EROSIONAL DAMAGE ON DOWNSTREAM SLOPE
FROM OVERTOPPING

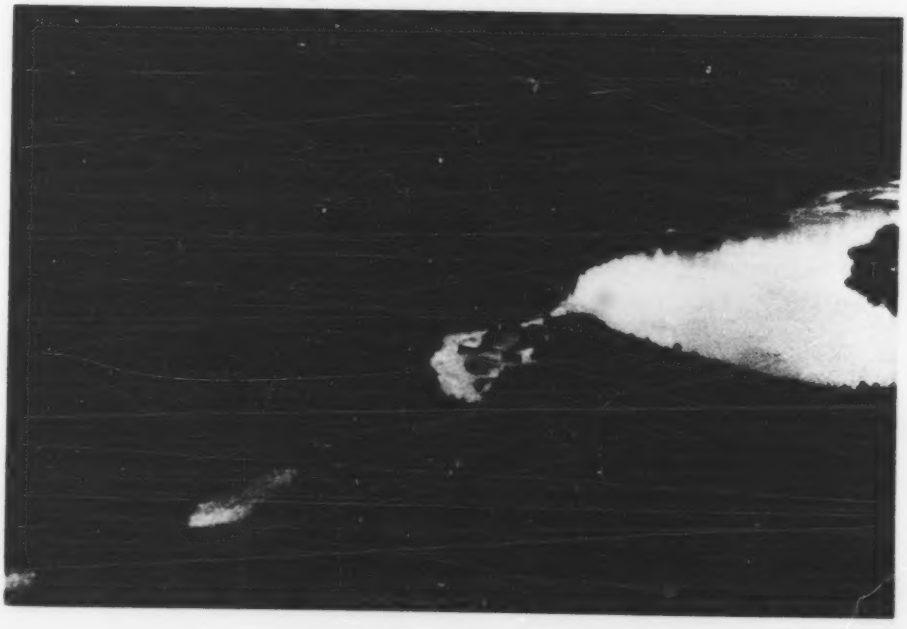


PHOTO NO. 9066-13
JULY 4, 1990

PHOTO NO. 9066-4
JULY 4, 1990

PHOTO NO. 9066-2
JULY 4, 1990

PHOTO NO. 9066-5
JULY 4, 1990

PHOTO NO. 9051-15
LOOKING UPSTREAM AT EROSIONAL DAMAGE
ON DOWNSTREAM SLOPE OF EMBANKMENT

PHOTO NO. 9051-2
DOWNSTREAM SLOPE EROSIONAL DAMAGE FROM LEFT SIDE

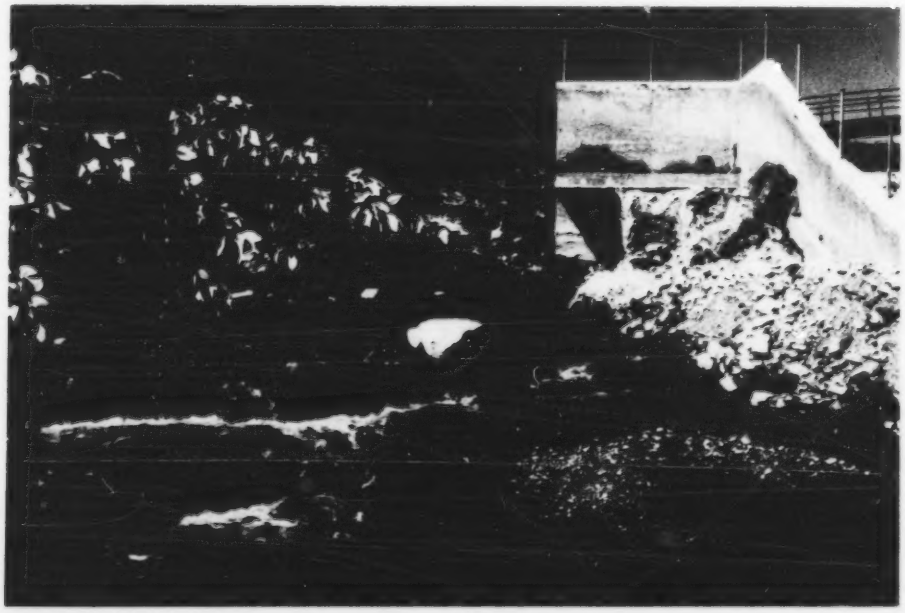


PHOTO NO. 9051-17
LOOKING UPSTREAM ALONG RIGHT SIDE OF
SPILLWAY, NOTE HANGING HEADWALL

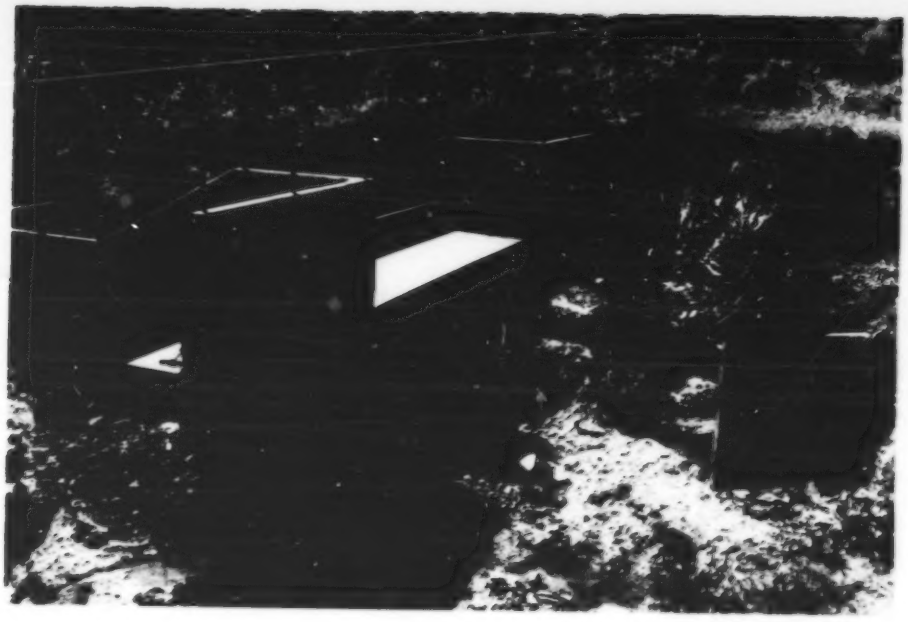


PHOTO NO. 9051-7

PHOTO NO. 9076-3
FARM CROSSING 0.25 KM BELOW RED MOUND PARK RESERVOIR
NOTE DEBRIS ON UPSTREAM SIDE OF BRIDGE AND DAMAGED
GAUGING STATION

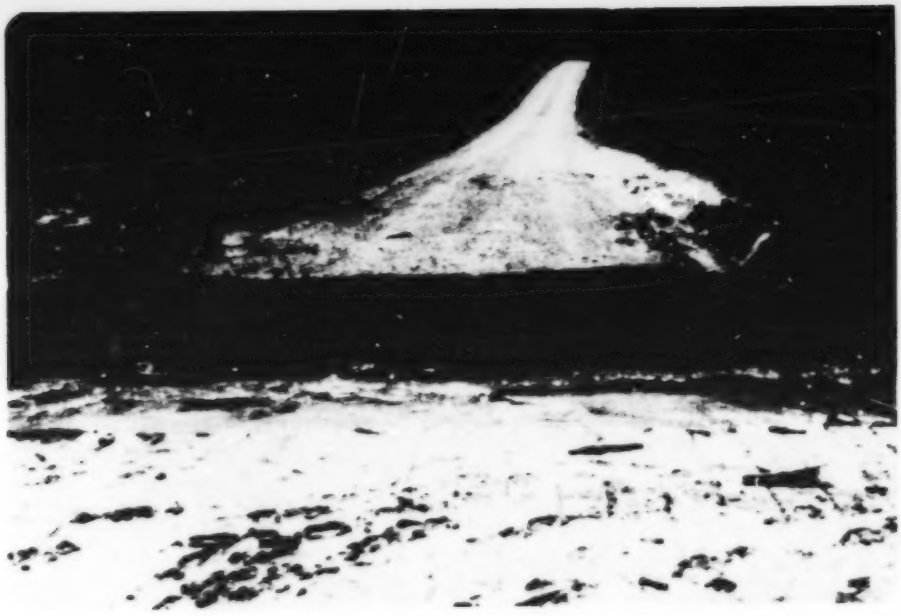
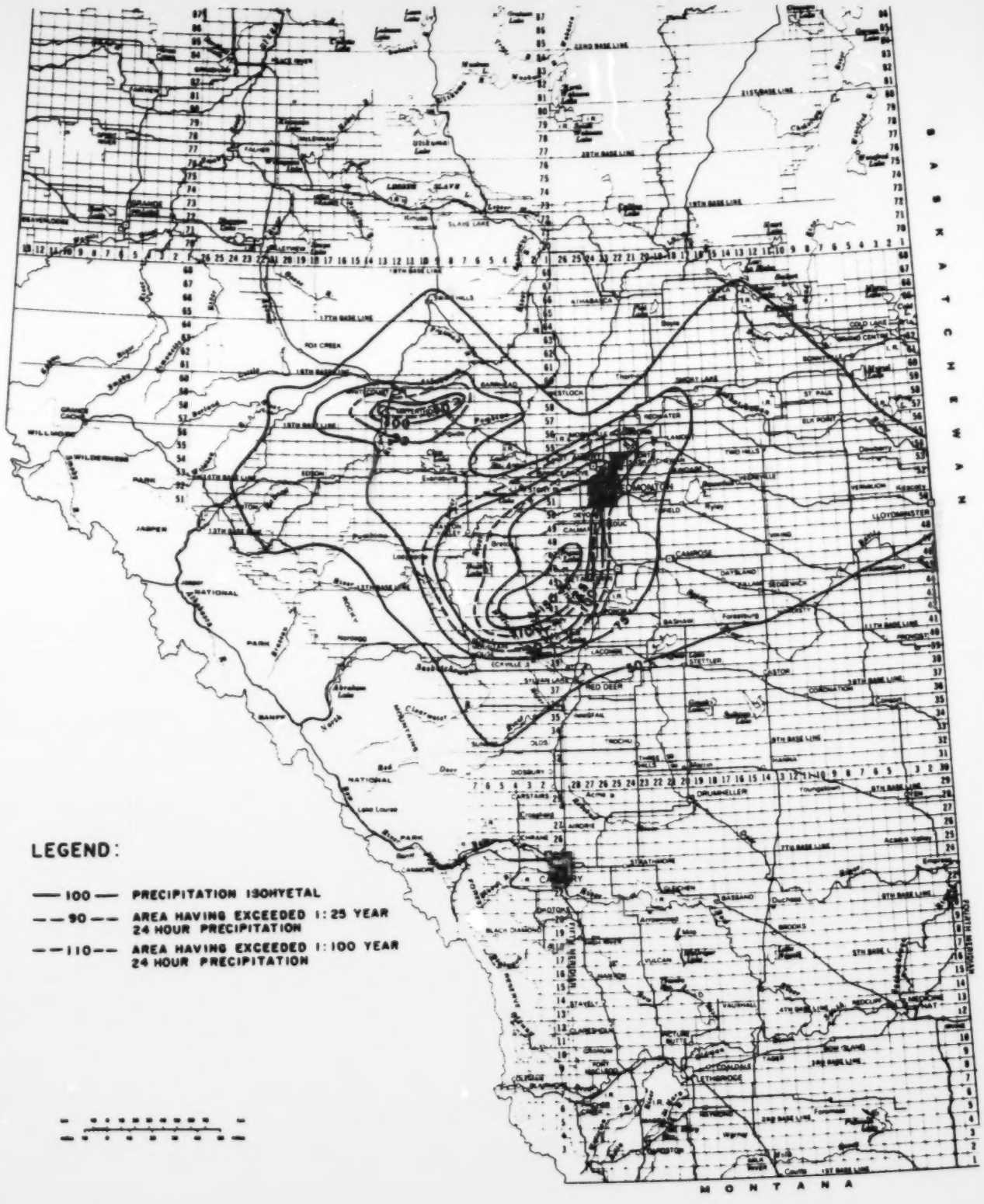


PHOTO 9076-2
ERODED ABUTMENT ON RIGHT SIDE
OF FARM CROSSING BRIDGE

PHOTO NO. 9076-1
LOOKING DOWNSTREAM AT BATTLE RIVER FROM
HIGHWAY #611 WEST OF USONA
JULY 4, 1990


0 10 20 30 40 50
SASKATCHEWAN
MONTANA
LEGEND:
100 PRECIPITATION ISOHYETAL
90 AREA HAVING EXCEEDED 1:25 YEAR 24 HOUR PRECIPITATION
110 AREA HAVING EXCEEDED 1:100 YEAR 24 HOUR PRECIPITATION

MICROFILM DATE

DRAWING No

Alberta ENVIRONMENT

MOUND RED PARK RESERVOIR (MUSKEG CREEK DAM)

STORM OF JULY 2 & 3, 1990

SUBMITTED DATE	DESIGNED CHECKED
APPROVED DATE	DRAWN CHECKED
SCALE AS SHOWN	SHEET OF
DATE APRIL 1991	DRAWING No

APPENDIX - DETAILED ANALYSIS OF FLOW CONDITIONS AT THE RESERVOIR AND IMMEDIATELY DOWNSTREAM

(Prepared By: Bob Froelich, P. Eng.)

Event: Flood of July 3, 1990

Precipitation: 24 hour precipitation reported by the farmer just south of dam = 8 inches

Field Observations/Calculations

A rough field survey was conducted on July 11, 1990 by Bob Froelich and Barry Hurndall using a rod and hand level to measure elevation differences and pacing to measure horizontal distances on the dam and dam breach.

A single cross-section was also taken across the whole valley at the location shown on the figure entitled "Profiles and Cross-sections" in the Appendix and high water marks were tied in. A slope/area flow computation was made using this data and assuming that Manning's n was 0.035 for the channel and 0.050 for the overbank areas. It resulted in a peak flow estimate of 67.8 cms (2400 cfs).

At the time the dam was visited by R. Pickering of Water Survey Branch on July 3th at 1:30 pm (DST), the reservoir water level had dropped approximately 0.2 m (0.7 feet) from the maximum. He also reported that the flow around the headwalls of the spillway had not yet produced visible erosion. A computation was made of estimated outflow from all components of the dam at that point in time. Spillway outflow was estimated to be 38.9 cms (1373 cfs), dam crest overflow was 0.79 cms (28 cfs), low level conduit outflow 0.71 cms (25 cfs) and dam breach outflow around the spillway and wingwalls (assuming no erosion) 1.0 cms (34 cfs) for a total of 46.6 cms (1644 cfs).

It seems very likely, however, that although not visible, some erosion had occurred by that time around the wingwalls. If it is assumed that it amounted to 2.0 feet in depth, and that the breach width had doubled, then the breach outflow around the spillway would have been about 206 cfs more than assumed above and total outflow would have been 52.4 cms (1850 cfs) at 1:30 p.m.

An estimate was also made of outflow when the reservoir water level was maximum. This gave a spillway flow of 44.5 cms (1571 cfs), dam crest overflow of 10.7 cms (379 cfs), wingwall overflow of 8.9 cms (313 cfs) and low level conduit flow of 0.71 cms (25 cfs). Assuming no erosion had occurred yet in the spillway area, outflow around the spillway and wingwalls was estimated to have been an additional 1.7 cms (59 cfs) - total 66.5 cms (2347 cfs).

Consequently, peak outflow was approximately 68.0 cms (2400 cfs) and occurred prior to there being any significant outflow through the breach that subsequently developed around the spillway structure. By the time Pickering arrived, according to the above calculations, outflows had dropped significantly to about 52.4 cms (1850 cfs). However, water levels at the downstream recorder immediately above the bridge and roadway were highest at this point in time. This likely happened just as debris blocked the bridge opening, and before the roadway was breached on both sides of the bridge.

Breach Development

The breach cut through the dam around the wingwalls until top-of-the-breach elevation was lowered 2.5 meters (8.2 feet) to the

elevation of the approach channel. This appears to have occurred within 24 hours of breaching (see picture taken from a plane) and is equivalent to 1.1 cms (38 cfs) averaged over 24 hours. One week later, the top-of-the-breach elevation had eroded down another 2.0 meters or so, according to the field survey, to essentially empty the reservoir (see photos). The location of the breach crest moved upstream along the approach channel as far as the reservoir in this time.

Rough Shape of the Hydrograph

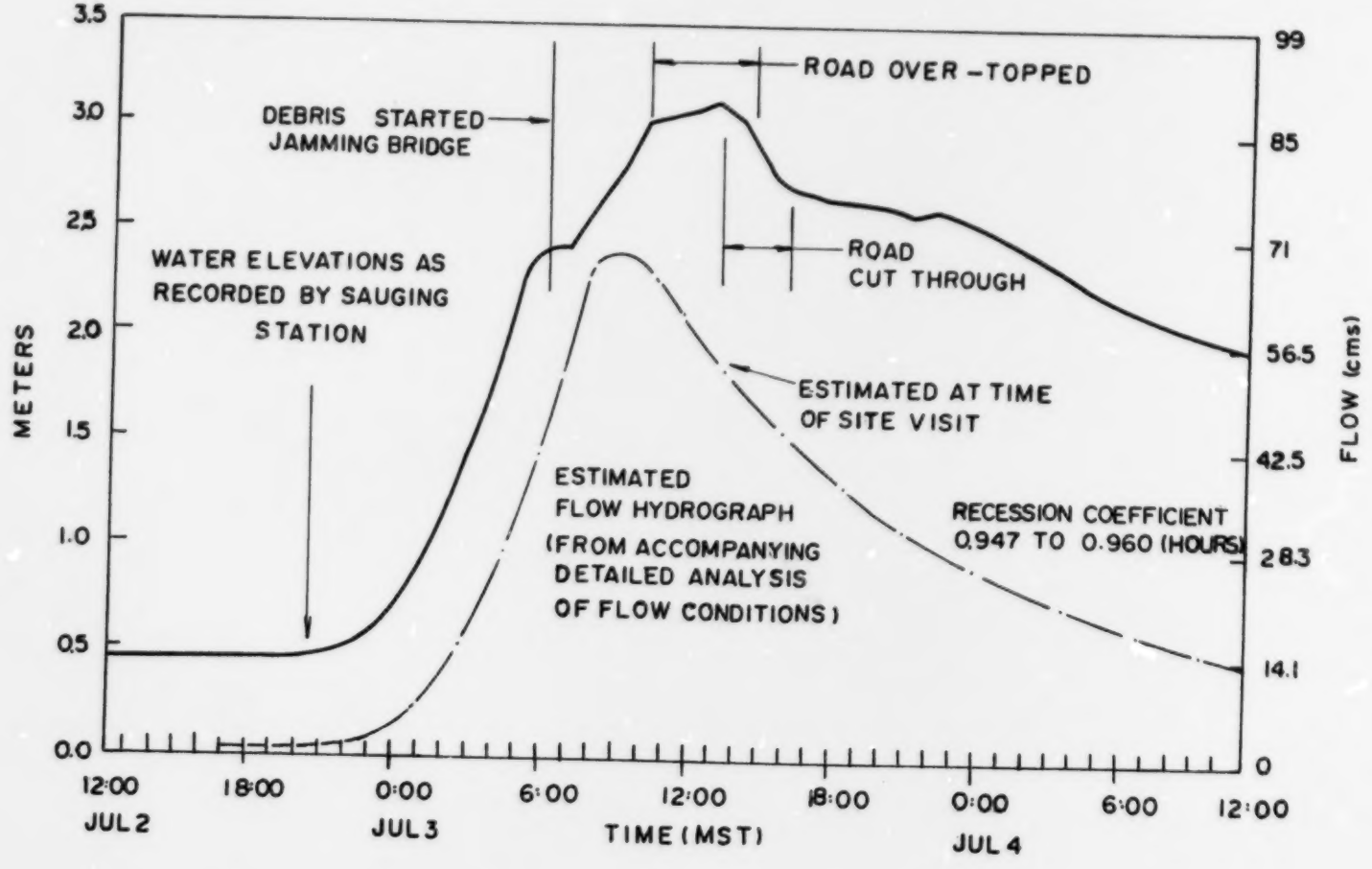
Up until the point where debris started to block the bridge opening at about 6:00 am (MST) July 3, the rating curve of the hydrometric station at the bridge was used to estimate the rising limb of the dam outflow hydrograph (see sketch). Given the calculated outflow at 1:30 pm July 3 and the calculated peak outflow, the remainder of a rough hydrograph was sketched. The hydrograph fits the data best if the time of the peak is set to 9:00 am. Hence, the increase in outflow over inflow due to the observed 0.2 m drop in reservoir level between 9:00 am and 1:30 pm would have been, on average, only 0.5 cms (16 cfs). This is negligible compared to likely errors in the flow estimates. As previously noted, the outflow from storage in the first 24 hours was also negligible. Hence the inflow hydrograph can be taken as equal to the outflow hydrograph.

Summary and Conclusions

The Mound Red dambreach developed so slowly and the reservoir storage was so small that there was negligible increase in dam outflow due to the breach (i.e. inflow equalled outflow). Peak outflow of 68.0 cms (2400 cfs) was equivalent to 0.76 cms/sq kilometer (72 cfs/sq. mile).

MUSKEG CREEK NEAR WESTEROSE (05FA912)

WATER ELEVATIONS AND ESTIMATED HYDROGRAPH FLOW



GEODETIC ELEVATIONS NOT AVAILABLE

Storm misery pounds central Alberta homes

By TONY BLAIS and MINDELLE JACOBS
Edmonton Sun

Near-record rainfalls have left central Alberta swamped.

About 15 million litres of raw sewage was dumped into the North Saskatchewan River yesterday as heavy rainfall lashed Edmonton.

The rainfall — more than the average for all of July — left more than 400 Edmonton basements flooded.

And in Thorsby — 60 km southwest of Edmonton — about 85 people were evacuated from their homes yesterday as torrential rains swamped roads, yards and houses.

Thorsby Mayor Phyllis Madiuk declared a local state of emergency. The town's high school became an evacuation centre.

Bonnie Kulak, Edmonton environmental services spokesman, said the untreated sewage was dumped along with 300 million litres of storm water.

"It's the biggest rainfall in quite a while, so it's probably the most raw sewage that has been dumped for some time," Kulak said.

"It's not a great, unusual occurrence — it's the way the system is designed."

If the city doesn't dump the untreated sewage into the river, it would back up into basements.

The city notified Alberta Environment about the sewage and was given permission.

Stuart Adams, Alberta Environment spokesman, said the province is monitoring the situation and would investigate.

The rainfall has raised the North Saskatchewan River more than 1.5 metres higher than normal.

Forecasters were predicting the level would rise another 3 metres by midnight tonight.

An Environment Canada spokesman said 110.4 mm of rain was recorded at the Edmonton Municipal Airport between 6 p.m. Monday and 6 p.m. yesterday.

Although the rain fell short of breaking the city's one-day rainfall record of 119.9 mm, set on July 31, 1953, it did surpass the 88.7 mm average rainfall for July.

Across the province, rivers and creeks from Edson to Edmonton and east to St. Paul swelled — threatening to spill over their banks.

"It's quite bad. From my living room window, you'd swear you were on a raft," said Thorsby resident Dave Zeiner, 44, whose rugs were sopping with 10 cm of water.

"The streets are flooded badly."

July 5/90 Edm Sun.

Ponoka mopping up

By TONY BLAIS and JUANITA NG
Staff Writers

Ponoka residents are mopping up today after the rain-swollen Battle River overflowed its banks, flooding at least 20 homes and resulting in the evacuation of seven families.

Ponoka Mayor Monica Chesney called a state of emergency at 8 a.m. yesterday as the usually mild river, which runs through the town of 5,500, rose at an alarming rate.

"It's a huge river flowing through the town where it usually is a small one," said Chesney.

The Battle River peaked about 6 p.m. with the water at 3.5 metres above its normal level of 1.2 metres.

Volunteers worked through the day using about 19,500 sandbags to shore up houses near the river to restrict the damage.

The town's North Bridge and a pedestrian bridge were both closed, as well as Highway 2A, Chesney said.

The seven evacuated families were staying with friends and families although the town secured the use of beds at Alberta Hospital.

Kristine Huddleston, her husband and their three children were forced to flee after the water completely flooded their basement and began creeping through the floorboards.

"I've never seen the river come up this high," Huddleston said. "It just came up so fast it surprised everybody."

The family were able to move things upstairs from the basement before it flooded but they were forced to return by boat later to rescue the TV and stereo.

"We were really swamped and it's going to be a really big mess," said Huddleston. "But there's not much you can do."

The town faced additional problems when its two pumping stations stopped operating, said the mayor.

"Our sewage disposal system has been overloaded and the sewage stations will end up pumping sewage into the river," said Chesney. "But at this time that is minor."

She didn't know how much raw sewage would end up in the river but said it wouldn't affect the drinking water.

Marcel Schayes, director of disaster services in Ponoka, said officials will ask the province to help pay to clean up the town, 104 km south of Edmonton.

Damage to homes is estimated at thousands of dollars.

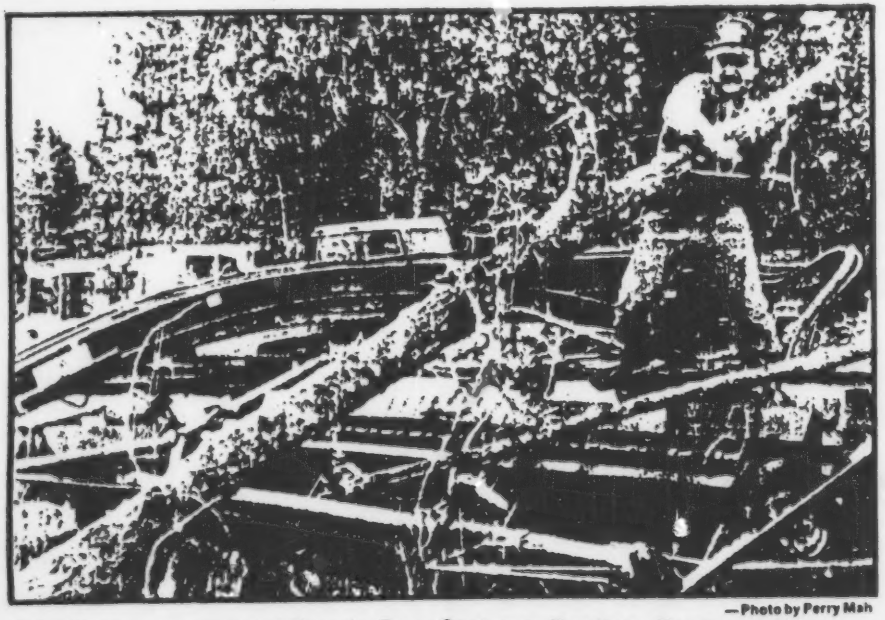
In Thorsby, 80 km southwest of Edmonton, Mayor Phyllis Madiuk said she'll also be seeking help from the province.

About 85 people were evacuated from flooded homes Tuesday as a state of emergency was called in that community.

Damage is estimated at hundreds of thousands of dollars.

Flood warnings remained in effect yesterday for the Paddle and Little Paddle Rivers near Mayerthorpe as well as the Blindman River near Blackfalds and the Medicine River near Eckville.

● Family rises to occasion — Page 18



— Photo by Perry Mah

John George, co-owner of Thorsby Farm Centre, pulls a tree off some machinery.

J4/4 6/90

River levels drop but new storm coming today

40 mm of rain expected

Journal

GERRY WARNER
Journal Staff Writer

Ponoka

River levels were dropping in flood-damaged central Alberta Thursday but nervous cleanup crews were bracing for another storm expected today.

A disturbance originating off the coast of Oregon is expected to dump as much as 40 mm of rain on the already soggy region where preliminary damage estimates range to more than $1 million.

"It may run into the millions but we really can't tell at this point," said Ponoka County spokesman Debbi Raugust.

Raugust said county officials viewed the area by air Thursday and were appalled by what they saw. "It's a real mess. There were farm buildings completely surrounded by water and farmers out in canoes."

Leduc County assistant manager Kevin Stone said rural road damage could top the $1-million mark with as many as 30 locations affected.

Alberta Transportation and Utilities is also facing a big bill, with the washout of Highway 39 at Weed Creek expected to cost $250,000 alone, said information officer Steve Coop. The severed arterial between Calmar and Thorsby will not reopen for at least three weeks, Coop said.

Meanwhile, Highway 2A two km south of Ponoka, which reopened briefly Thursday morning, was closed again at noon when a six metre by two metre hole developed in the road at the north end of the Battle River bridge.

Motorists are being detoured along Highway 2, and Highway 2A is not expected to reopen until noon today, said regional bridge engineer Randy Shalagan.

States of emergency were still in effect in Ponoka and Thorsby. Ponoka Mayor Monica Chesney said the state of emergency will stay in effect through the weekend while officials monitor the Battle River.

"I think we were very fortunate keeping damage as minimal as it was but we're not going to take any chances," Chesney said.

Window-level water destroyed one house in Ponoka and about a dozen other homes suffered varying degrees of damage, Chesney said.

Twenty tractors and several other pieces of farm equipment suffered extensive damage at the Thorsby Farm Centre when rampaging Weed Creek overflowed its banks, submerging the equipment in two metres of water.

Water, which filled the basement of the Thorsby Hotel, did more than $5,000 damage to the steam boiler system, said hotel owner Daryl Hostyn.

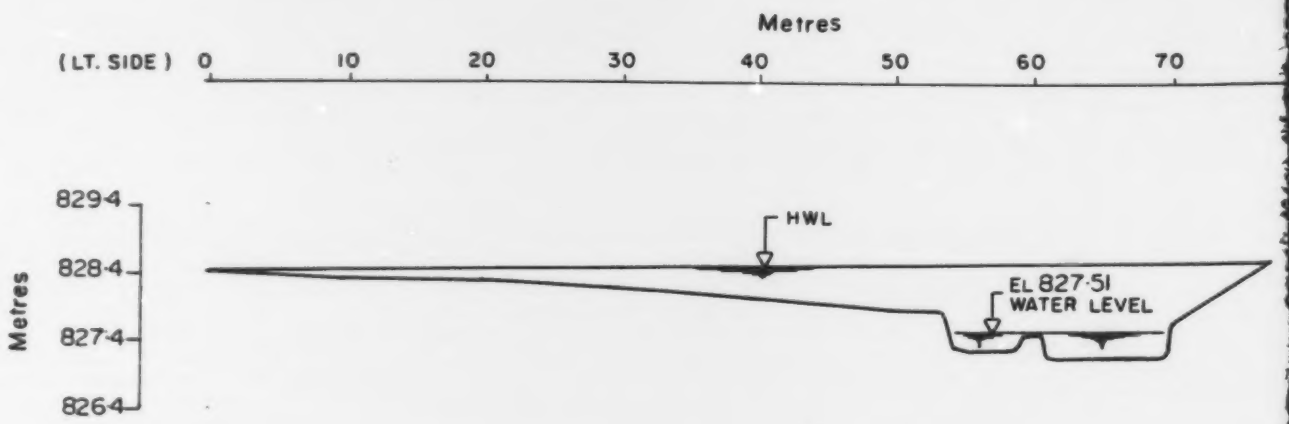
Thorsby administrator Barb Seino said the state of emergency will stay in effect until officials confirm the village's water supply is safe to drink.

More than a dozen boats were recovered on Pigeon Lake after they broke free during high winds accompanying Tuesday's storm, said Pigeon Lake regional constabulary Const. Al Musser.

Ripening of wheat, barley and canola crops in the flooded regions could be set back two weeks, and the quality of the crops could be reduced, said Alberta Agriculture crop statistician Michelle Gietz.

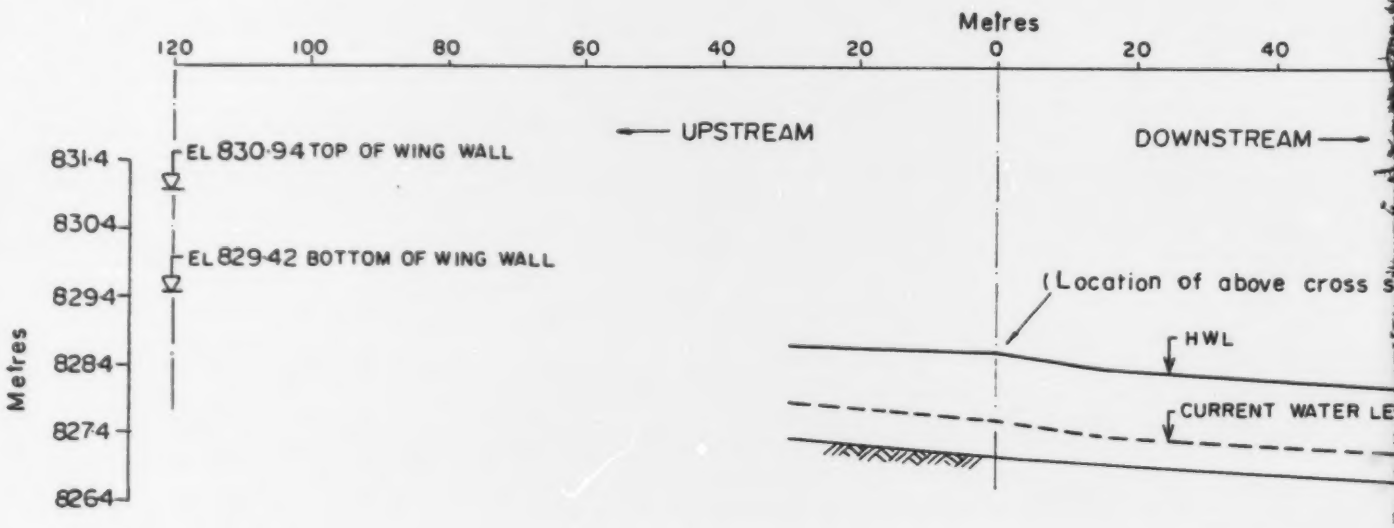
Atmospheric Environment Services weather specialist Mike Edwards said rain is expected to begin late Friday and continue until Saturday afternoon. "But we're not expecting anything like the monsoon which came through Tuesday."

More flooding will depend on the amount of precipitation and where it falls the heaviest, said Darlene Dickinson, information officer with the River Forecast Centre.



CROSS SECTION (APPROXIMATELY 12

SCALE Hor. 1:500 Ver. 1:100



PROFILE OF MAIN CHAN

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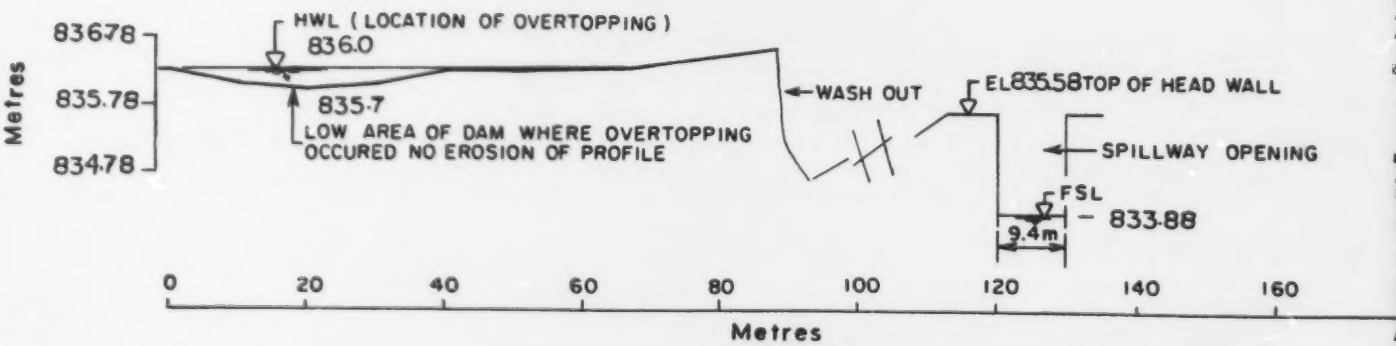


PROFILE

SCALE Hor. 1:1000 Ver. 1:100

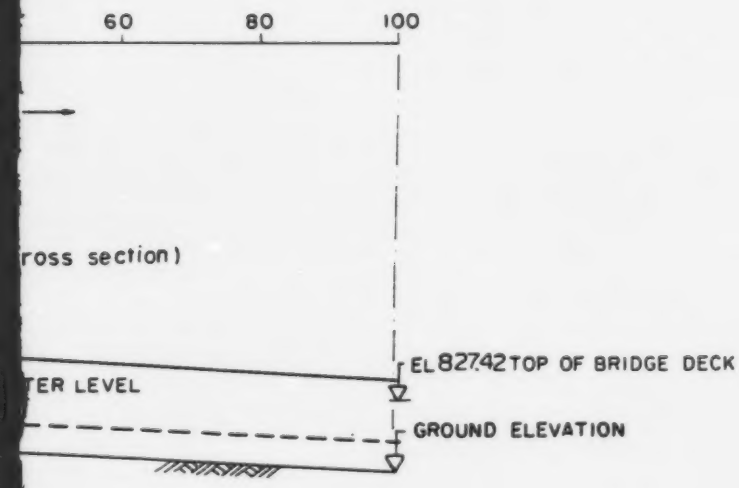
P3 – 280×430

60 80 100

80 (RT. SIDE)

Location of this cross section is shown on figure titled
"Erosional Damage - Main Dam and General Plan"

ELY 120 m FROM WING WALL)



CHANNEL

00

Nota All distances and elevations were obtained by pacing and hand level

180

Alberta ENVIRONMENT DESIGN AND CONSTRUCTION DIVISION		MOUND RED PARK
SUBMITTED ..... DATE	DESIGNED ..... CHECKED	PROFILES & CROSS SECTION NW 11-45-18-4
APPROVED ..... DATE	DRAWN D.W. CHECKED	SCALE AS SHOWN / SHEET OF / DATE NOV. 1990 / DRAWING No.

GENERAL PLAN

SCALE: 1" = 800' = (1: 9600)

LEGEND:

(12) DEPTH OF

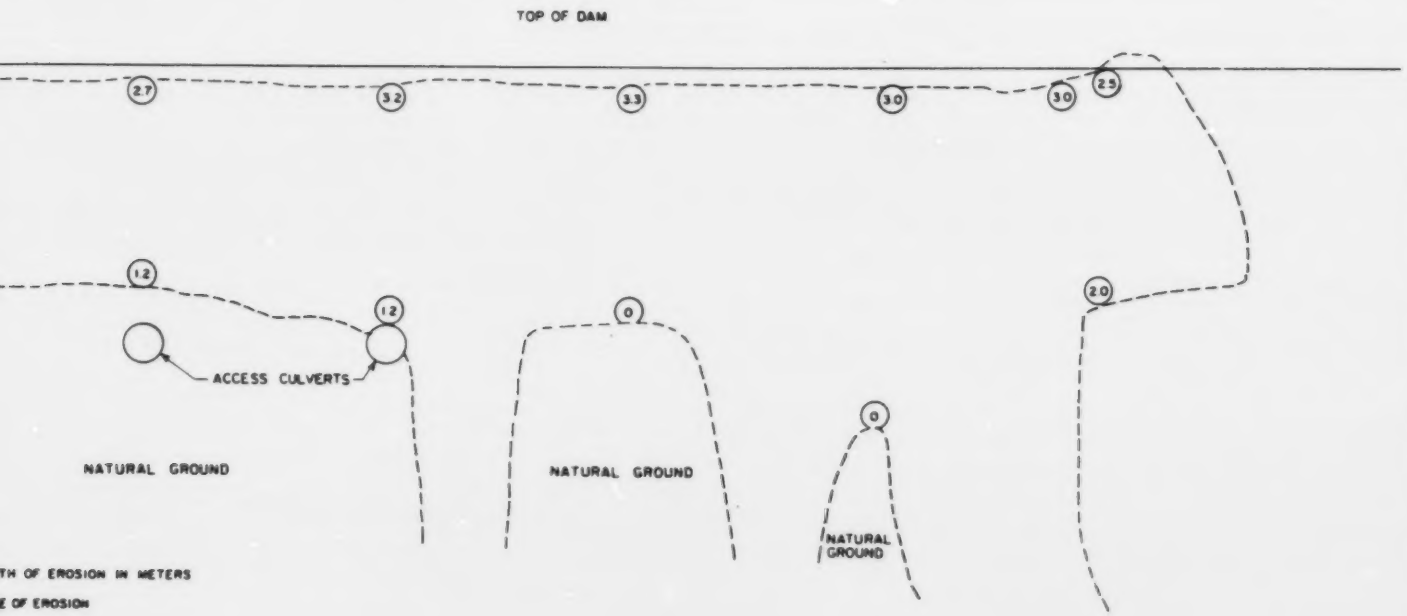
EDGE OF

MICROFILM DATE

DRAWING FILE NO

CENTRAL FILE NO.

NATURE OF REVI



PLAN
SCALE: 1:200

REVISION	DATE	ENG.	DWN.

Alberta ENVIRONMENT — DEVELOPMENT AND OPERATIONS DIVISION

SUBMITTED	DESIGNED .....
DATE	CHECKED .....
APPROVED	DRAWN .....
DATE	CHECKED .....

MOUND RED PARK

EROSIONAL DAMAGE - MAIN DAM AND GENERAL PLAN

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DATE	NOV. 1980	DWG. No.	

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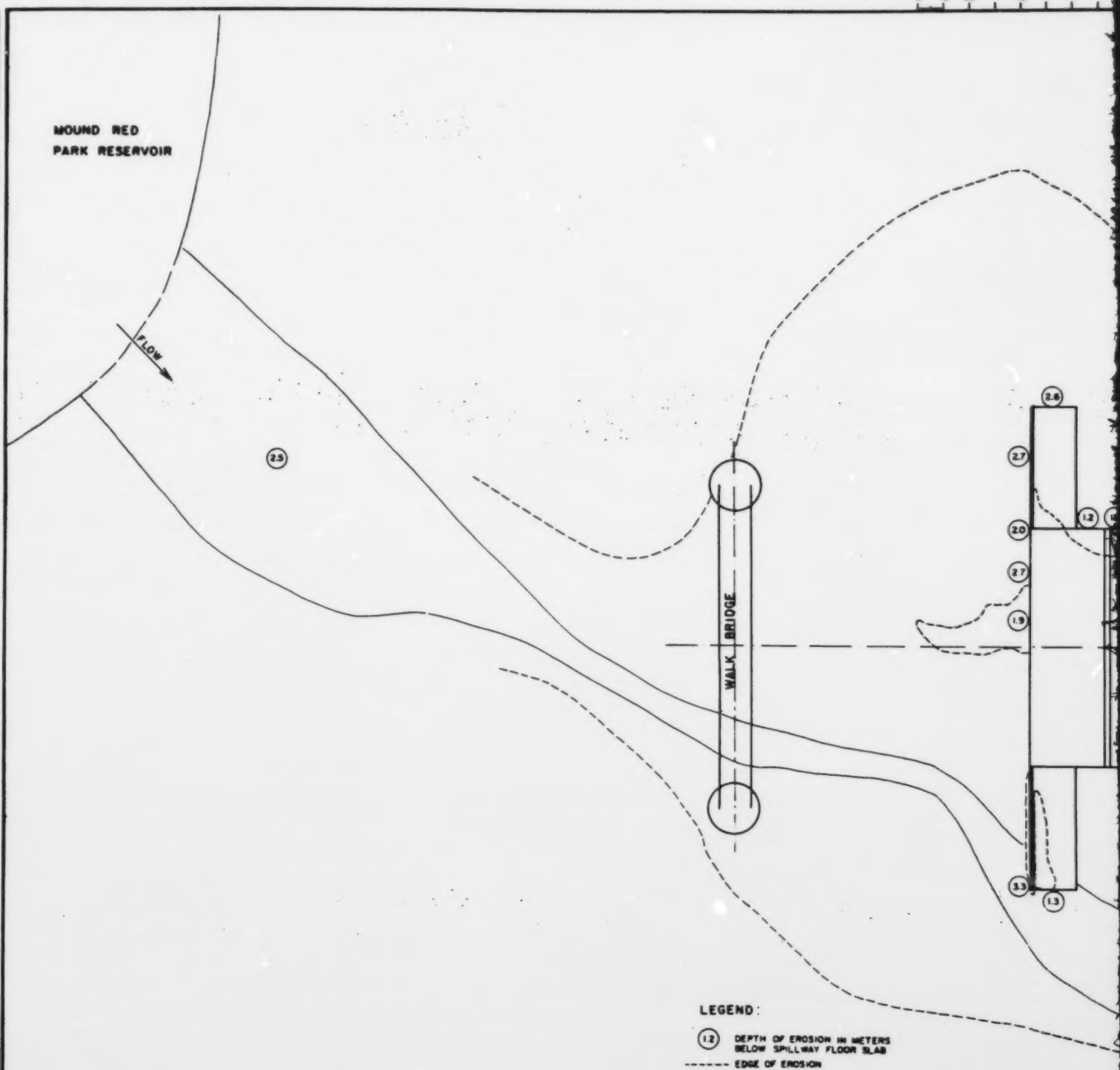

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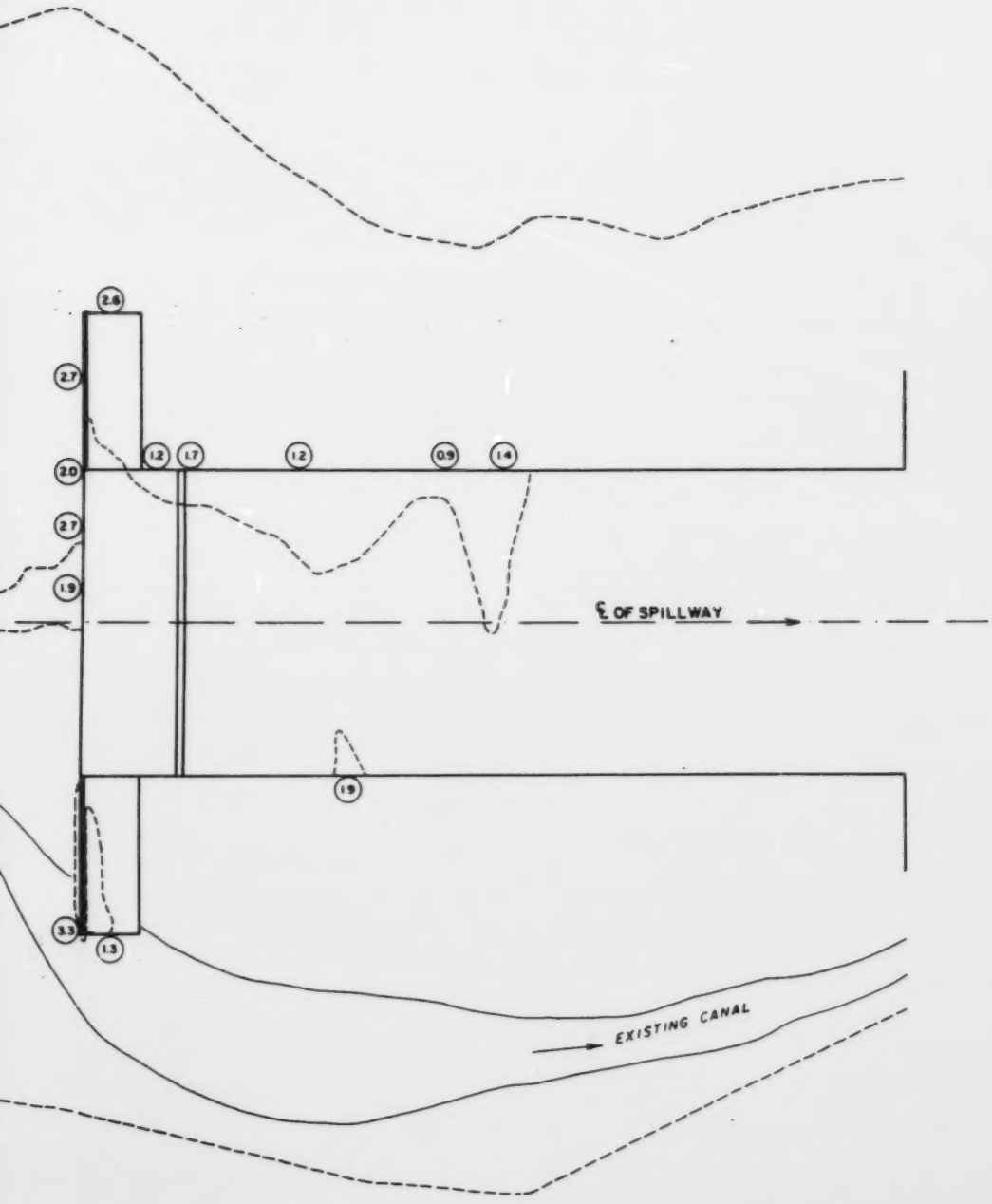

				Alberta ENVIRONMENT DEVELOPMENT AND OPERATIONS DIVISION		MOUND RED PARK
				SUBMITTED	DESIGNED	EROSIONAL DAMAGE - SPILLWAY AREA
				DATE	CHECKED	
				APPROVED	DRAWN	SCALE: 1: 200 / SHEET OF
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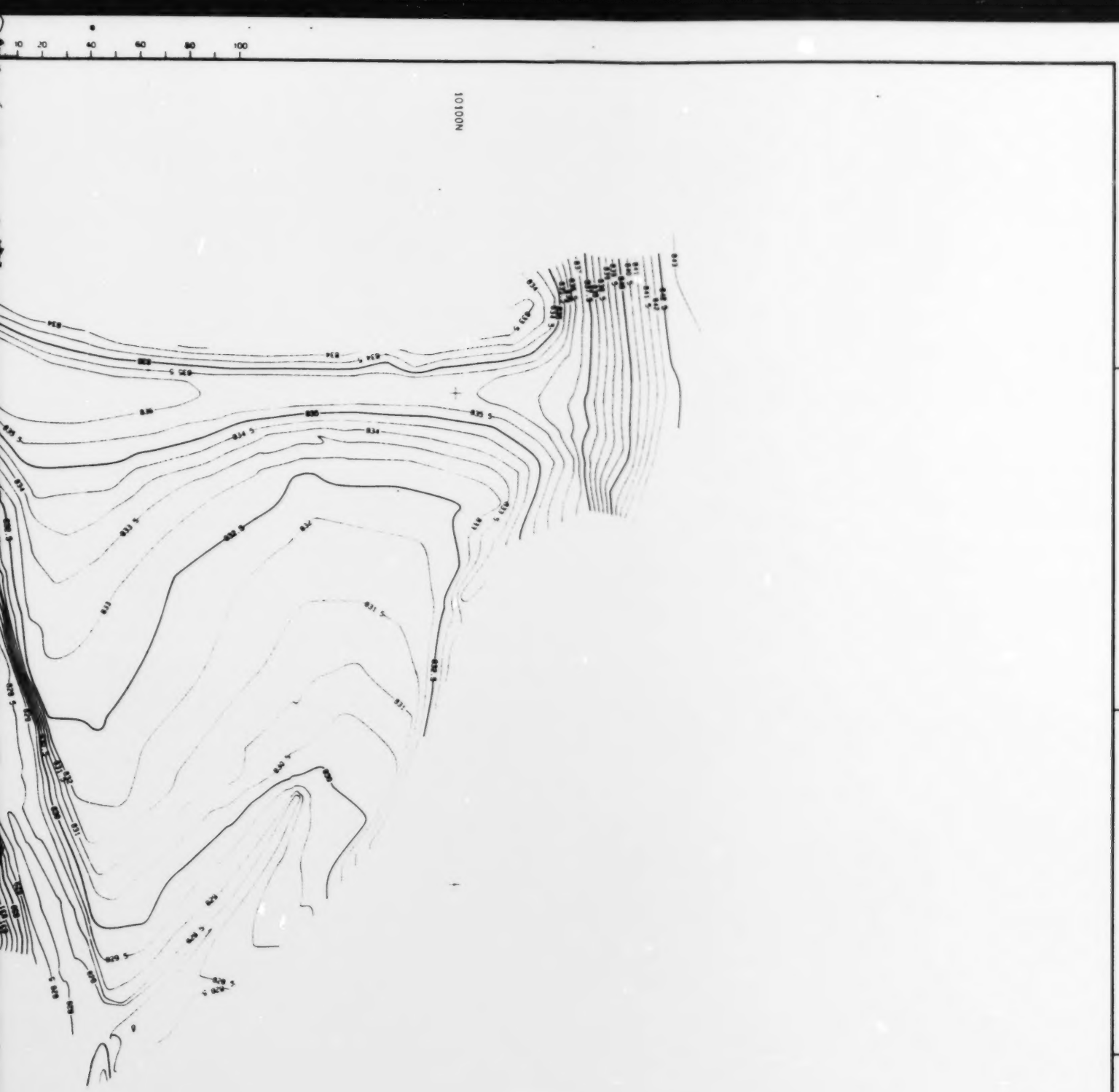

Think SAFETY First

NATURE OF REVISION	DATE	ENG.	DWN.

Alberta ENVIRONMENT — DEVELOPMENT AND OPERATIONS DIVISION

SUBMITTED	DESIGNED
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APPROVED	DRAWN
DATE	CHECKED

MOUND RED PARK

CONTOUR PLAN - DEC. 1988

SCALE : 1:100	SHEET OF
DATE : NOV. 1990	DWG No

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